SPROUT GROWTH FOLLOWING WINTER AND SPRING FELLING WITH AND WITHOUT SUMMER BROADCAST BURNING

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Abstract. – Young naturally regenerated pine-hardwood stands are often characterized by vigorous hardwood sprouts overtopping pine seedlings. For several years, mixed stands have been regenerated successfully in the Southern Appalachians by planting pines in hardwood clearcuts. Hardwood competition has been controlled by spring felling of residual stems and summer broadcast burning. This study documents the effect of these treatments on first-year sprout growth in the Piedmont of South Carolina. Four treatments were imposed following a commercial clearcut: (1) winter felling of residuals, (2) spring felling of residuals, (3) winter felling followed by a summer broadcast burn, and (4) spring felling followed by a summer broadcast burn. Spring felling followed by a summer burn provided the greatest control of height growth and crown spread of hardwood sprouts. The effect of burning was more important than season of felling because of the reduced time for sprout development. Number of sprouts per clump was generally unaffected.

INTRODUCTION

Approximately 80 percent of the forested land of the Southeast Piedmont area is owned by individuals or family groups. The tracts are small (average about ten acres) and most are cutover lands or old abandoned farms. The existing timber on these scattered lands is, for the most part, of low quality and is usually comprised of mixed pine-hardwood or hardwood species that are not highly desirable or suitable for the production of commercial wood products (McMinn 1983). An inexpensive regeneration system to change these low-quality stands to a productive state is needed.

A site preparation technique called fell and burn has been used in the Southern Appalachians to effectively and economically establish mixed pine-hardwood stands on certain sites (Phillips and Abercrombie 1987). The fell-and-burn procedure is described in detail elsewhere in these proceedings (Waldrop and others 1989) and consists of spring felling of residual stems (after clearcutting) followed by a summer broadcast burn. The objective of this study was to determine the effects of season of felling and summer burning on sprout development.

METHODS

Study sites are located on the Clemson University Experimental Forest. These sites were selected for consistency and similarity of aspect, soil, and vegetation. Before harvesting in December 1987 and March 1988, major tree species included white oak (Quercus alba L.), southern red oak (Q. falcata Michaux.), black oak (Q. velutina Lam.), scarlet oak (Q. coccinea Muenchh.) chestnut oak (Q. prinus L.), hickory (Carya sp.), and shortleaf pine (Pinus echinata Miller). Minor tree species included blackgum (Nyssa sylvatica Marshall), sourwood (Oxydendron arboreum (L.) DC.), dogwood (Cornus florida L.) and yellow-poplar (Liriodendron tulipifera L.). Slopes averaged 7 to 10 percent on all replications. All soils were described as Typic Hapludults.

Before harvest, 87 1/40th acre plots were established in three replications of four treatments. Treatments included:

1. winter felling of residuals with no burning,
2. spring felling of residuals with no burning,
3. winter felling of residuals with summer broadcast burning, and
4. spring felling of residuals with summer broadcast burning.

Spring felling was compared to winter felling to determine if sprout growth is reduced by felling when carbohydrate reserves are typically low. Chainsaw crews felled all residual stems over 5 feet tall that were present after commercial clearcutting. Winter felling was completed in early March 1988; spring felling was conducted in June 1988.

Burning took place on July 7, 1988, two days after a rainfall of 1/2 inch. Humidity at the time of burning was 50-60 percent and wind speed was approximately five MPH. Moisture content of 10-hour timelag fuels (1/2-1 inch in diameter) was 12 percent at 10:00 A.M. and 9 to 10 percent after noon.

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Burning was accomplished with hand crews and drip torches. Backing fires were started along the edge of the units until a sufficient blackened strip was attained. Strip head fires were used to ignite the interior fuels. Fuel loading varied from little or none to very heavy, depending upon disturbance by skidding and the presence of tree tops. Fuels consisted of large logs, old down materials, freshly felled residuals, tops, branches, leaf litter and new growth. Fuel loading before and after the broadcast burn was determined by the planar intersect method (Brown 1971). Sizes, quantities, and depths of fuels were measured.

Data collected at the end of the first growing season included: 1) stump height and diameter, 2) number of sprouts per stump, 3) height of the dominant sprout on each stump and 4) crown diameter of each sprout clump.

Treatments were compared by analysis of variance and means separation was by linear contrast. Number of sprouts per stump, height of the dominant sprout and diameter of the sprout clump were used as indicators of sprout growth. Treatment differences were compared with each variable for the common species or species groups including: oak, hickory, blackgum, other hardwoods and all species combined.

RESULTS AND DISCUSSION

Broadcast burns were of high-intensity with flames reaching heights of 10 to 15 feet where fuel loading was heavy. However, fire severity was low with exposure of mineral soil on no more than 22 percent of the burned areas (table 1).

Burning in spring-felled areas was more complete and uniform than in winter felled areas. Loading of fine fuels (.5 inch diameter) prior to burning averaged 0.4 ton per acre in both winter- and spring-felled areas (table 1). After the burn, fine fuel loading had been reduced by 75 percent in the spring-felled areas but by only 50 percent in the winter-felled areas. The depth of all fuels was reduced by 77 percent in spring-felled areas and by 54 percent in winter-felled areas. These differences were partially due to the presence of leaves on the stems felled during spring. After a tree is cut, the transpirational function of leaves continues to remove water from the bole and branches (McMinn 1986). Dry leaves also served as fuels to carry the fire.

Species composition of regeneration closely resembled that of the pre-harvest stand. Regeneration at the end of the first-year growing season (table 2) consisted of scarlet oak, southern red oak,

Table 2.--Species composition of regeneration.

Species	Stems per acre
Shortleaf Pine	57
Select oaks[a]	4,290
Hickory	1,350
Blackgum	1,647
Other Hardwoods	4,347
Total	11,691

[a] Scarlet oak (Quercus coccinea Muenchh.), southern red oak (Q. falcata Michx.), white oak (Q. alba L.), post oak (Q. stellata Wangenh.), black oak (Q. velutina Lam.), chestnut oak (Q. prinus L.).

Table 1.--Characteristics of fuels and exposed soils before and after burning by season of felling.

	Winter felled	Spring felled
Weight of fine fuels (<0.5 in dia)	(tons per ac)	
Before burning	0.4	0.4
After burning	0.2	0.1
Percent reduction	50	75
Depth of all fuels	(in)	
Before burning	8.5	7.7
After burning	3.9	1.8
Percent reduction	54	77
Soil exposure	(pct)	
Before burning	4.0	7.6
After burning	22.1	20.3

Table 3.--Average number of sprouts per stump by species group and treatment.

Treatment	Oak	Hickory	Blackgum	Other Hardwoods	All Species
Winter fell/no burn	5.7 a[1]	2.1 a	5.6 a	14.6 a	7.8 a
Spring fell/no burn	5.1 a	4.7 b	4.6 a	12.4 ab	6.8 a
Winter fell/burn	6.5 a	4.3 b	5.9 a	11.3 ab	7.4 a
Spring fell/burn	4.2 a	4.1 b	4.6 a	10.1 b	7.0 a

[1]Means followed by the same letter within a column are not significantly different at the 0.05 level.

white oak, post oak (Q. stellata Wangenh.), black oak, chestnut oak, hickories, blackgum, sourwood and dogwood. Minor species included black cherry (Prunus serotina Ehrhart), red maple (Acer rubrum L.), yellow-poplar, holly (Ilex opaca Aiton), persimmon (Diospyros viginiana L.) sassafras (Sassafras albidum (Nuttall) Nees) and hawthorn (Crataegus spp.). Primary invader species were present in the burned areas, but few or none were found in the unburned treatments. These invader species included vetch (Vicia spp.), butterfly pea (Clitoria mariana L.), fireweed (Erechtites hieracifolia (L.) Raf), and pokeweed (Phytolacca americana L.).

Spring felling and summer burning had little effect on the number of sprouts per stump for oaks, blackgum, and all species combined (table 3). For hickory, the winter fell treatment with no burning produced significantly fewer sprouts per stump than other treatments. In the other hardwoods group, the number of sprouts per stump was reduced to some degree by spring felling alone and by winter felling with burning. The combination of spring felling and burning produced the fewest sprouts per cut stem. These findings appear to contradict those of Augspurger and others (1987) and Waldrop and others (1985) who found that the number of sprouts per acre was increased by fire. However, this difference may be due to the shorter growing period of this study or from the methods used to determine sprout numbers (on a per acre basis vs. a per stump basis). Since burning created open conditions, additional seedlings and sprouts may develop during the second growing season.

Summer broadcast burning reduced the height of the dominant sprout of most species groups by approximately 50 percent (table 4). Spring felling with summer burning reduced height more than did winter felling and burning and produced a significant reduction in the growth of blackgum, hickory, and other hardwoods. Spring felling without burning had little affect on height growth. These results suggest two primary advantages of spring felling over winter felling: 1) spring felling provides fuels for more uniform and timely burning and 2) spring felling contributes to the overall control of hardwood sprout growth in the fell-and-burn method. Of the two components, burning had

Table 4. Average height (in) of dominant sprout by species group and treatment.

Treatment	Oak	Hickory	Blackgum	Other Hardwoods	All Species
Winter fell/no burn	39.7 a[1]	18.1 a	30.6 a	41.9 a	36.4 a
Spring fell/no burn	36.2 a	14.7 ab	29.5 a	40.7 a	32.4 b
Winter fell/burn	18.7 b	13.5 b	24.0 a	23.1 b	18.3 c
Spring fell/burn	18.6 b	9.5 c	12.5 b	18.8 c	15.8 c

[1]Means followed by the same letter within a column are not significantly different at the 0.05 level.

more effect on growth than spring felling. The reduction in height of competing hardwoods on burned plots was due to a shorter growing period rather than an inhibitive response to burning (Danielovich and others 1987).

The average diameter of the crowns of sprout clumps was affected by summer burning and spring felling (table 5). Burning significantly reduced crown diameters of oak, other hardwoods, and all species combined. Without burning, spring felling had no effect. However, the combination of spring felling and burning produced the smallest crown diameters of all treatments. Similar to height growth, burning was more critical for controlling crown spread than season of felling. However, spring felling produced more uniform burning conditions.

SUMMARY AND CONCLUSIONS

Spring felling of leafed-out residuals followed by summer burning (fell-and- burn site preparation) produced the greatest reductions in heights of the dominant sprouts and crown diameters of sprout clumps. Of the variables measured, number of sprouts per stump was least affected by the treatments. Burning reduced average sprout height for most species from generally over 3 feet to less than 1.5 feet. Spring felling with summer burning was more effective than winter felling and burning in reducing growth of several species groups. Reduction of dominant sprout heights and crown diameters should reduce shading of planted pines thus allowing the successful establishment of a pine-hardwood mixture. Reduced growth of sprouts was attributed primarily to a shortened time to develop after burning, although sprout vigor may also have been affected.

The oaks appeared to be somewhat less affected by spring felling than each of the other species groups. After burning, sprouts of hickory, blackgum, and other hardwoods were smaller (height and crown diameter) in spring felled areas than in areas where felling was conducted in the winter (tables 4 and 5). The oaks showed no significant reductions in height growth or crown spread due to spring felling. If this pattern remains apparent over several growing seasons, the combination of spring felling and summer burning may prove beneficial to establishment of the more desirable oak species.

The success of the fell-and-burn technique for establishing pine-hardwood mixtures has been attributed, in part, to controlling hardwood sprout growth (Phillips and Abercrombie 1987, Danielovich and others 1987). This control was assumed to be the effect of carefully timed broadcast burning and felling of residuals when carbohydrates are in low supply. After a single growing season, this study shows that the fell-and-burn technique effectively reduced hardwood growth in the Piedmont of South Carolina. The reduced size of hardwood sprouts (both height and crown diameter) was primarily due to burning. Felling residual stems during the spring was less effective in reducing sprout growth than anticipated. Without burning, spring felling had little affect on sprout growth.

Table 5.--Average diameter (in) of clump crown by species group and treatment.

Treatment	Oak	Hickory	Blackgum	Other Hardwoods	All Species
Winter fell/no burn	24.0 a[1]	10.1 ab	24.1 a	33.3 a	24.9 a
Spring fell/no burn	24.1 a	10.3 a	22.7 a	29.3 a	22.9 a
Winter fell/burn	18.1 b	11.8 a	21.8 a	20.0 b	16.1 b
Spring fell/burn	13.6 b	7.9 b	10.3 b	16.0 c	13.2 c

[1]Means followed by the same letter within a column are not significantly different at the 0.05 level.

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